ANCHOVY SPAWNING IN PORTUGUESE ESTUARIES (*ENGRAULIS ENCRASICOLUS*, PISCES : ENGRAULIDAE).

by

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ABSTRACT. – The present paper deals with the preferential spawning of *Engraulis encrasicolus* in the two biggest portuguese estuaries. References are made to certain aspects of its spawning in Tejo and Sado estuaries such as the annual occurrence and abundance of ichthyoplankton, spatial distribution of eggs and larvae, mortality and dimensions of eggs and larval retention within the estuaries.

RÉSUMÉ. – Dans ce travail nous exposons les conclusions sur la ponte préférentielles de l'anchois (*Engraulis encrasicolus*) dans les deux estuaires les plus importants de la côte portugaise. Certains aspects de sa ponte dans les estuaires du Tejo et du Sado sont abordés, tels que la présence et l'abondance de l'ichtyoplancton, ainsi que la distribution spaciale des œufs et des larves, la mortalité et les dimensions des œufs et la permanence des larves à l'intérieur de ces estuaires.

Engraulis encrasicolus was found to spawn preferentially in the two biggest portuguese estuaries (Tejo and Sado). A preliminary survey of fish eggs and larvae occuring in Tejo estuary was made during the year of 1978 by Ré (1979b). In this paper three species were found to use the estuary as a primary spawning area ; *Engraulis encrasicolus, Syngnathus abaster* and *Pomatoschistus minutus.* Among these only *E. encrasicolus* enters the estuary to spawn, *S. abaster* and *P. minutus* are resident species.

Ré *et al.* (1982) sampled a suprisingly small number of *E. encrasicolus* eggs during a one year ichthyoplankton survey in the central part of the portuguese coast. Sobral (1975) also found a small number of eggs (major concentrations were found in the adjacent sea of two northern estuaries). Finally Ré (1979a) sampled a certain number of eggs near the mouth of a southern portuguese estuary.

These results allied to the fact that eggs and larvae of *E. encrasicolus* may be found in great concentrations inside the two surveyed estuaries led us to believe that this species spawns preferentially in the estuaries along the portuguese coast.

The present paper deals with certain aspects of its spawning in Tejo and Sado estuaries such as the annual occurence and abundance of ichthyoplankton, spatial

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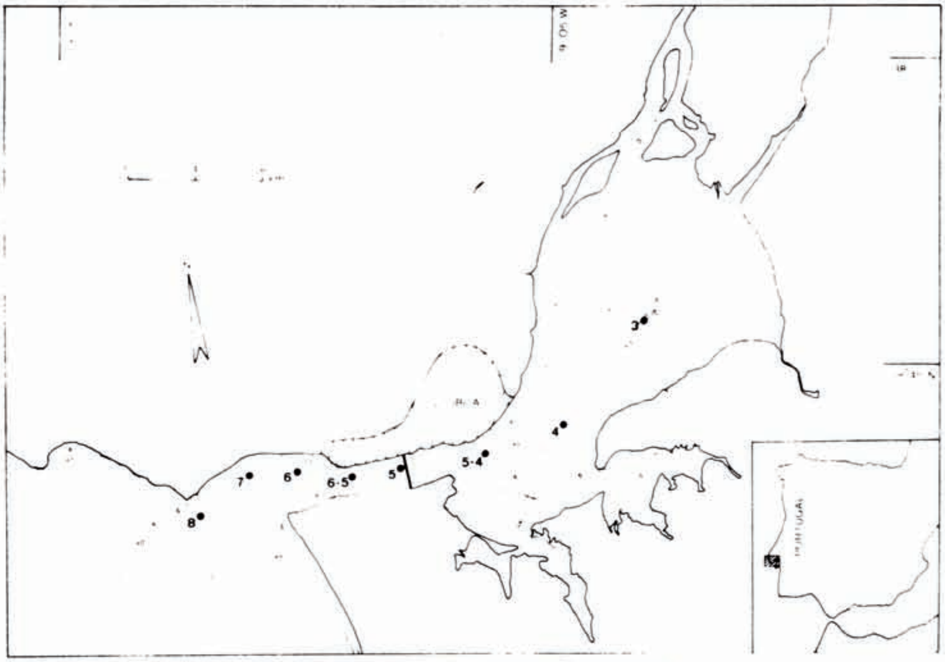

Fig. 1. – Grid of stations sampled in Tejo estuary.

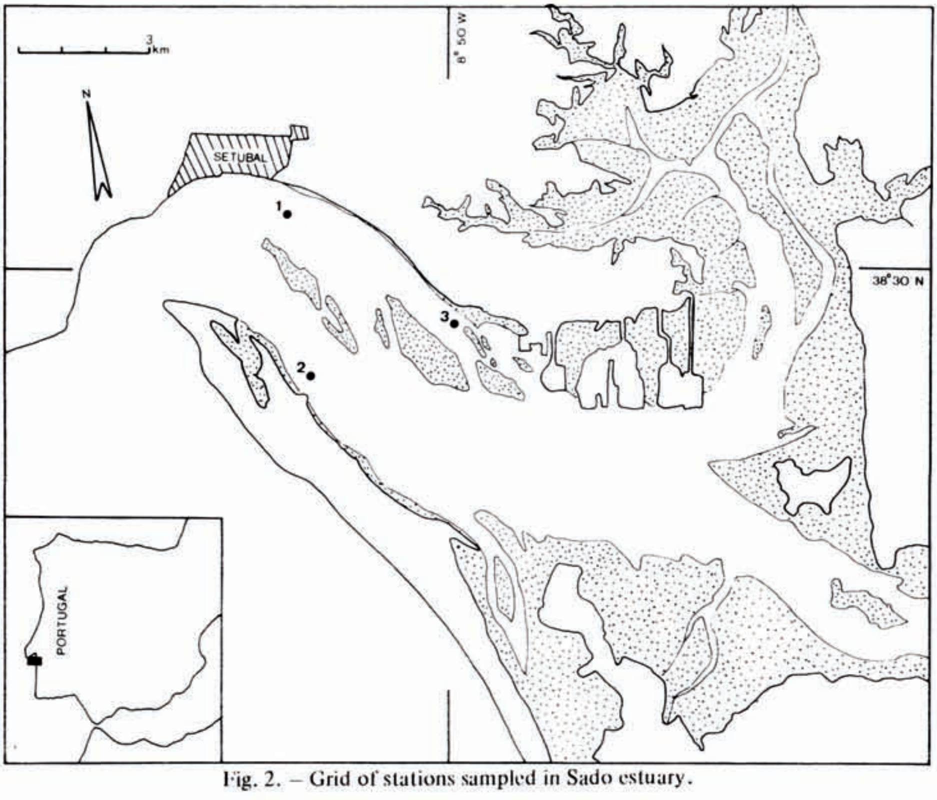

Fig. 2. – Grid of stations sampled in Sado estuary.

distribution of eggs and larvae, mortality and dimensions of eggs and larvae retention within the estuaries.

Material and Methods

Study area.

Tejo estuary is a relatively big tidal estuary located on the central part of the portuguese coast (Figure 1). It extends inland about 80 km and has an area of 320 km^2. Maximum depth may reach 40 meters near the mouth but its value is much lower in the interior portions of the estuary (under 10 meters). Tides are of semi-diurnal type with a mean tidal range of 2.6 meters.

Sado estuary is located south of Tejo estuary and has a much lower surface area (Figure 2). Tidal influence is present as far as 45 km upstream and its range varies from 1 to 3.5 meters. Maximum depth at the mouth reaches 40 meters.

Methods.

Different sampling methods and gears were used in the refered estuaries. In Tejo estuary samples were taken at 8 stations (Figure 1) with a 1 meter plankton net of 0.500 mm mesh aperture. Three successive oblique-step hauls were made per station at a speed of 1,5 to 2 knots. The towing time was in all cases 10 minutes and the average volume of water strained 400 m^3.

In Sado estuary a WP-2 plankton net was used. Horizontal surface tows were made at three stations (Figure 2) during a period of 15 minutes at a constant speed of 2 knots. The average volume of water strained was 225 m^3.

Sampling was carried only during daylight hours, between 9:00 and 16:00 local time.

Tows did not coincide with any particular tidal stage in Tejo estuary. In Sado estuary samples were taken during ebb and flood tide.

Samples were fixed immediatly after collection with 5% formalin buffered with borax. Final preservation was also made with 5% formalin.

Larvae were sorted entirely at the laboratory with the aid of a low power stereomicroscope.

Whenever the eggs were very abundant only an aliquot was studied. A Folsom plankton splitter was used in this case.

Mortality of the eggs was estimated as the percentage of dead eggs in the total sample (Ré, 1981).

Viable eggs were measured with a calibrated micrometer eyepiece and a stereomicroscope to the nearest one hundredth millimeter and larvae were separated into 1 millimeter length classes (all measurements were made on preserved material).

Results and Discussion

Spawning activity and spatial distribution of eggs and larvae. .

It is generally accepted that the anchovy withstands 5 to 45 o/oo salinity and 6 to 20°C temperatures ranges, and that there is no limiting factor for the general distribution in the Mediterranean and adjacent seas. Eggs and larvae are rarely found in waters which have a temperature lower than 13°C, the most favourable

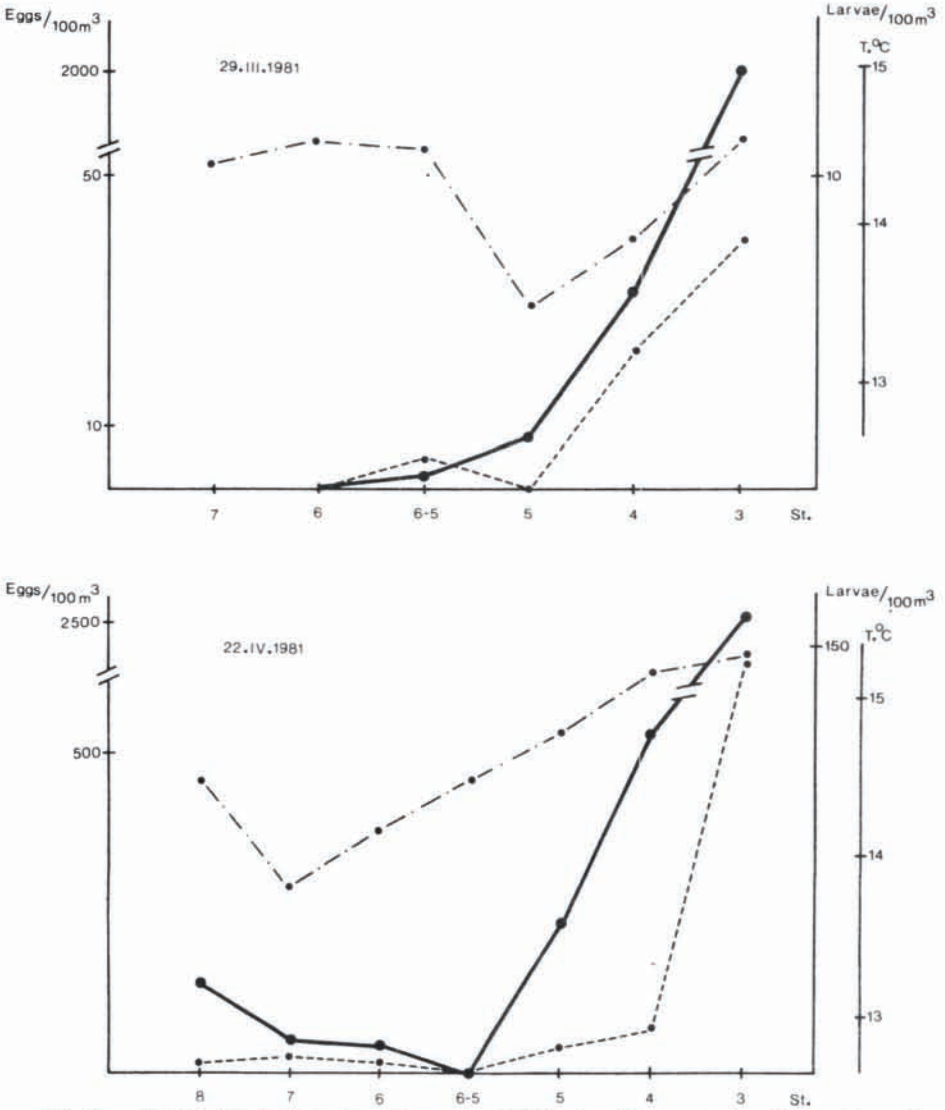

Fig. 3. – Spatial distribution of anchovy eggs (full line) and larvae (broken line) collected in Tejo estuary in March and April. The broken and dotted line indicates the variation of surface temperatures reccorded at each station.

temperature range beeing 15 to 25ºC and 9 to 37.5 o/oo salinity (Demir, 1965).

Anchovy spawning in relation to some environmental factors was studied by several authors in the Mediterranean (Aboussouan, 1964 ; Aldebert & Tournier, 1971 ; Chavance, 1980), Bay of Biscay (Arbault & Lacroix,1971 - 1977), Marmara sea (Demir, 1974). The abundance and distribution of anchovy seems to be closely related to physical parameters such as temperature and salinity. Dekhnik & Sinyoukova (1964 *in* Demir , 1974) refer that in waters of low salinity (7-20o/oo) anchovies form large shoals occuring everywhere and spawning both in inshore and offshore waters, whereas in the seas which have higher salinity (34 - 39 0/00) the anchovies form small shoals and spawn generally in coastal waters.

Nevertheless the fact that this species might spawn preferentially inside an estuary have not been mentioned previously, to our knowledge. The only brief reference to this situation was made by Martinez (1977) who studied the ichthyoplankton of an estuary situated in the northern part of the Iberian peninsula (Ria de Arosa).

Anchovy eggs and larvae were collected from March to June in Tejo estuary and from February to June in Sado estuary. In the two surveyed estuaries spawning activity was higher in April.

In Tejo estuary, eggs and planktonic stages were sampled predominantly in the upper estuary (Stations 3 and 4) where higher water temperatures were registered. This situation was always found independently of the tide, maximum spawning occuring through a temperature range of 13.8 to 15.3ºC. The spatial distribution of the spawning is given, for Tejo estuary in figures 3 and 4.

These data led us to believe that spawning should take place, with greater intensity, at the interior portion of the estuary and that there might be a system of larval movements which retain the anchovy larvae within the estuary in spite of its seaward flow. This subject will be discussed later on.

Egg mortality.

Egg mortality rates were also investigated. These were considerably higher in Tejo than in Sado estuary (Figure 5). In the former the mean egg mortality varied from 60 to 93 % and showed a marked increase as the spawning season progressed. In the later a high value was found in April and considerable smaller values were registered in March and June. Nevertheless comparisons of mortality rates from catches by different methods and gears are difficult to make.

In both estuaries considerable differences were found in the rate of motality recorded at different stations. In Tejo estuary highest mortality rates were found, during the surveyed period, at upper stations.

In the two estuaries mortality was found to be higher in early than in late embryonic stages.

Causes of egg mortality are very complex and have to be related to several hydrological and biological parameters such as temperature, salinity, dissolved oxygen, pollution, mechanical damage and solar radiation among others. An evaluation of the role played by each of the refered parameters is difficult to make and requires a specific study.

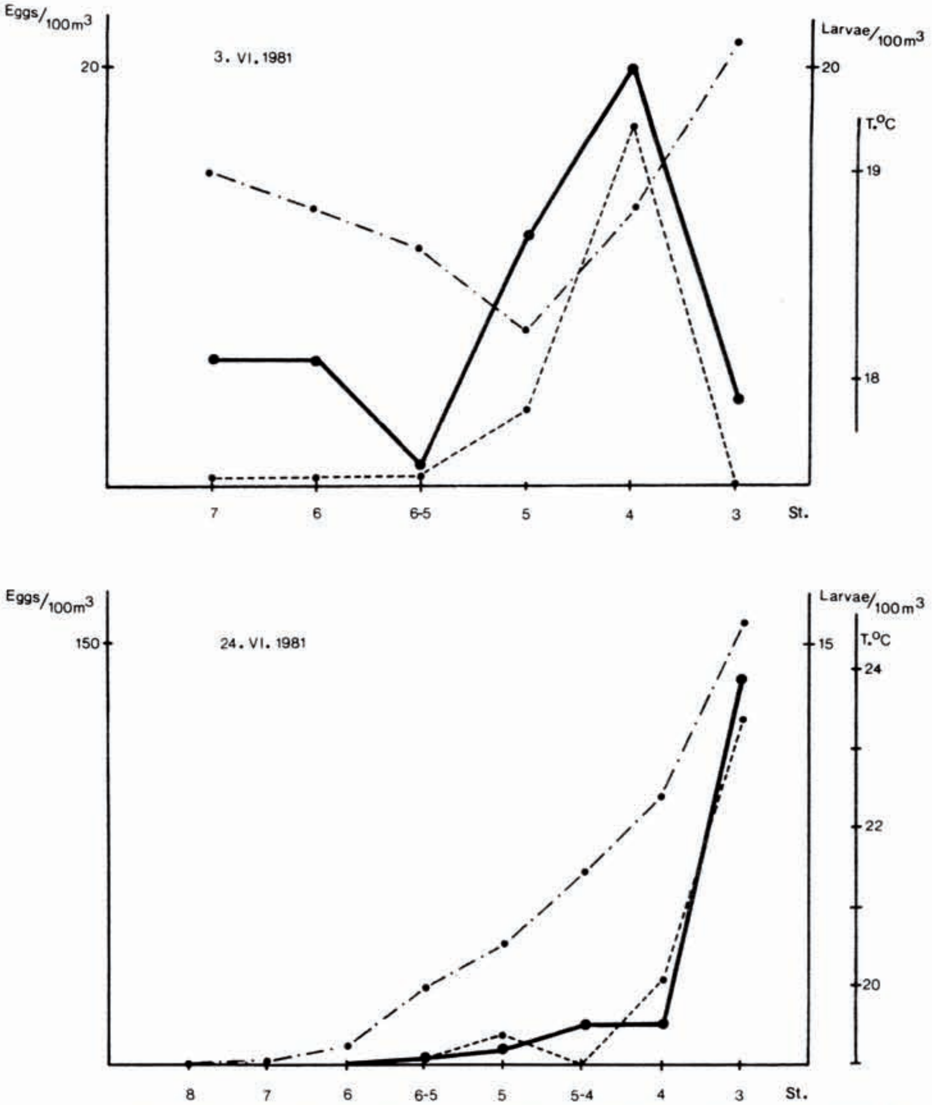

Fig. 4. – Spatial distribution of anchovy eggs (full line) and larvae (broken line) collected in Tejo estuary in June. The broken and dotted line represents the variation of surface temperatures.

Egg size.

Concerning the egg dimensions it is well established that temperature and salinity, among other factors, have a direct influence in egg size. Although Bagenal (1971) refers that there is not any direct connection between variation in egg size and variation of temperature and salinity, other authors are not of the same opinion. Southward & Demir (1974) found a direct influence of temperature on the rate of maturation of the oocytes, so that a larger number of smaller eggs would be produced in the warmer months and a reduced number of larger eggs in the cooler months of the year. According to Ciechomski (1973) the fact that the average size of the eggs of *Engraulis anchoita* decreases as the spawning season progresses might be related to the partial spawning of this species or the length composition of the spawners correlated with the differences in growth rate in relation to the temperature.

The size of anchovy eggs collected in the two estuaries decreased considerably as the spawning season progressed (Figure 6). Temperatures reccorded in June were, of course, higher than those registered in March suggesting that there might be some connection between this factor and the refered variation of egg size.

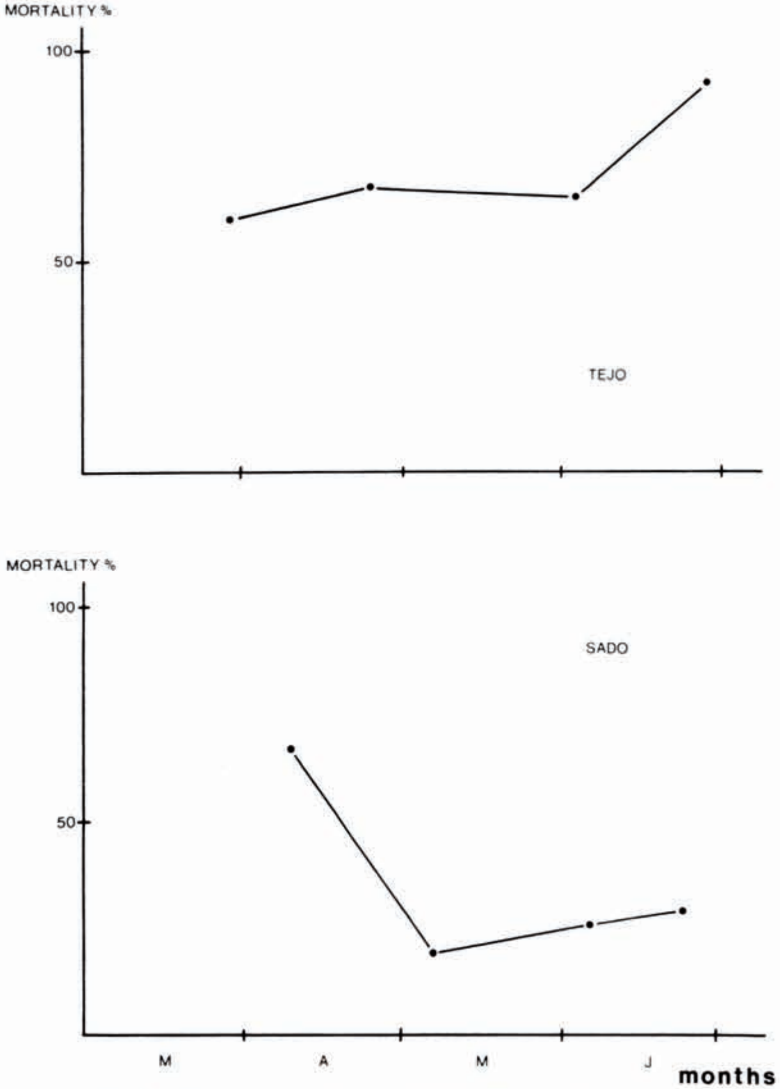

Fig. 5. – Mean egg mortality recorded in Tejo and Sado estuaries.

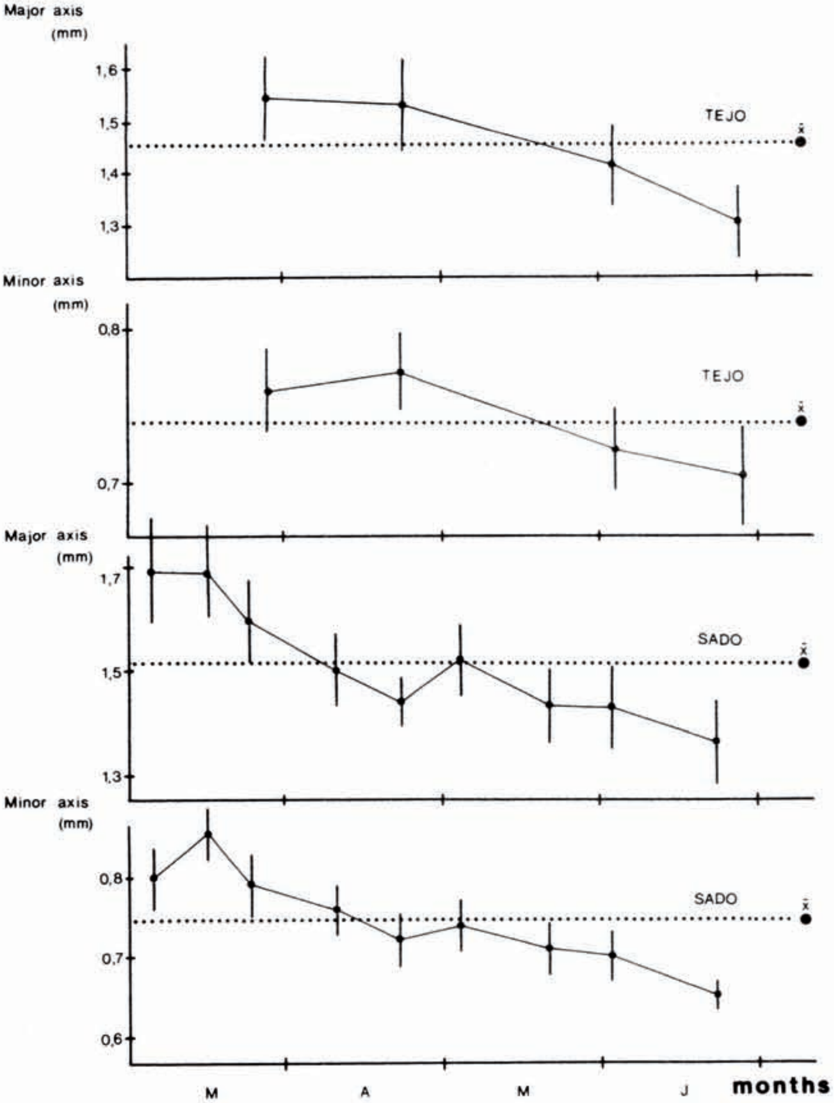

Fig. 6. – Egg dimensions (major and minor axis) recorded in Tejo and Sado estuaries. Monthly means with one standard deviation to either side are given. The dotted line indicates the mean of all samples.

Retention of larval anchovy within Tejo estuary.

The fact that anchovy larvae were present in great concentrations in the upper portion of Tejo estuary (Figures 3 and 4) and that larvae of higher length-classes were always found at interior stations independently of the tide (figure 7), made us suspect that there must be some kind of larval movement responsible for its retention inside the estuary.

An identical situation was described by Graham (1972) for *Clupea harengus.* After this author larval herring maintained their position in the upper estuary by (1) occupying the landward tidal flow near the bottom, (2) moving upward upon reaching the limit of their landward penetration, (3) then seaward in the flow near the surface, and (4) finally descending again into the landward flow. The utilization of tidal currents by estuarine zooplankton was also described by Woolbridge &

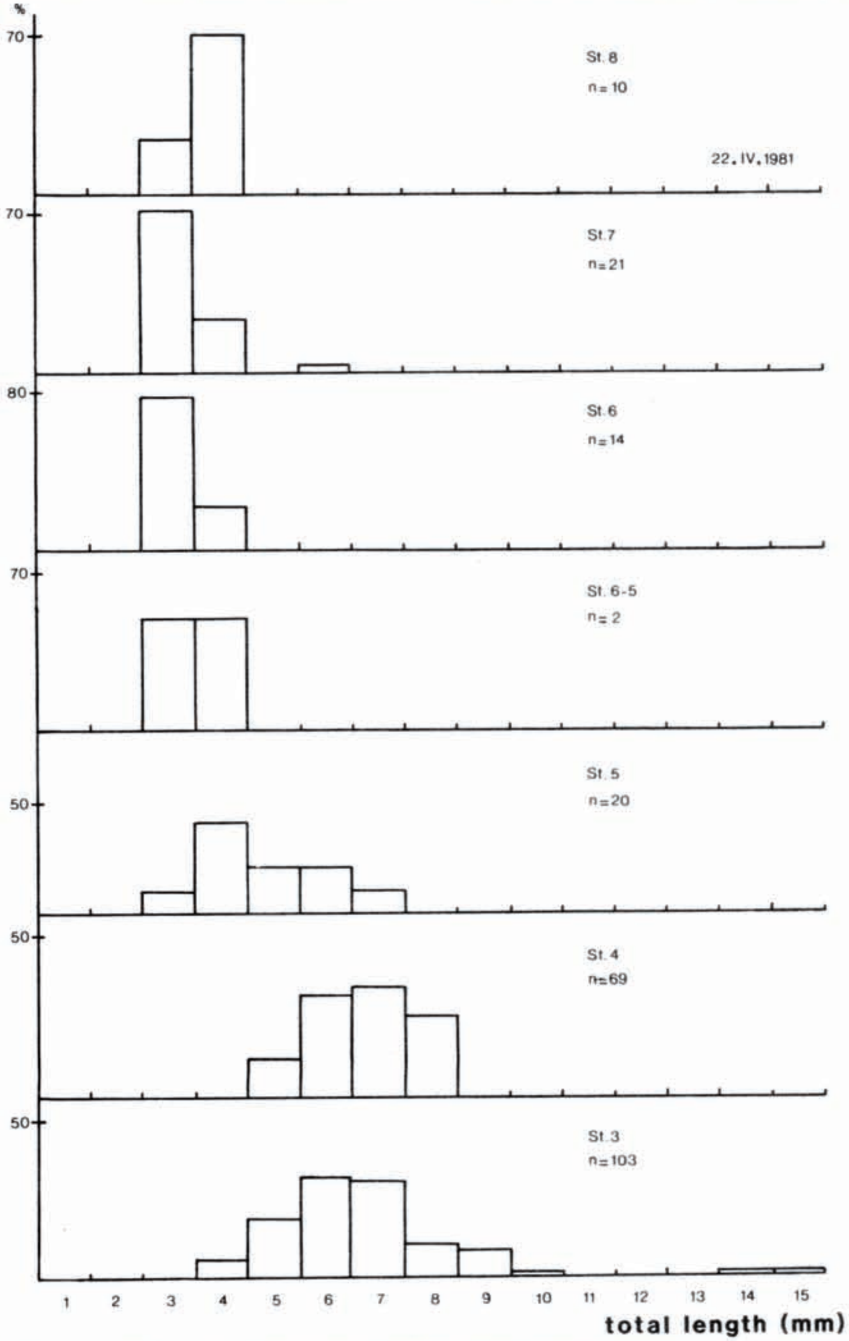

Fig. 7. – Length-frequency histograms of anchovy larvae sampled per station during April in Tejo estuary.

Erasmus (1980). These authors refer that both vertical and lateral migration seem to be important factors aiding the retention of indigenous zooplancton within an estuary.

The conformation of the referred larval retention within Tejo estuary will envolve a different sampling methodology. We reserve this task for a future work.

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